Montana Nutrient WQBELs Analysis

Introduction

Montana has adopted and EPA has approved numeric nutrient criteria (NNC) and a statewide general variance that allows for the application of alternative interim NNC criteria for those dischargers that qualify. Per EPA's approval letter, those facilities that would have to treat their effluent with reverse osmosis automatically qualify under the affordability analysis. However, it is unclear exactly to which Montana publicly-owned treatment plants (POTWs) that threshold currently applies.

Tetra Tech conducted an analysis to determine: 1. What would be the water quality-based effluent limits (WQBELs) appropriate to each Montana POTW and private dischargers based on instream conditions (absent the use of a variance, compliance schedule or other flexibility), and do such limits require the facility to upgrade to RO, thus qualifying for the general variance; and 2. For those facilities that would not qualify under the general variance, could they potentially qualify for an individual NNC variance?

Tetra Tech completed a WQBEL analysis for Montana POTWs and private facilities. EPA provided a comprehensive list of dischargers to be used for this analysis. EPA/ MDEQ also provided Tetra Tech with a copy of fact sheets for the complete list of dischargers. Tetra Tech used this information to characterize nutrient concentrations in the effluent for purposes of the analysis. In situations where nutrient effluent data were not available, Tetra Tech and EPA coordinated to determine alternate data sources and/or assumptions to be used to characterize the effluent concentrations.

WQBEL Methods

For all facilities that had projected downstream concentrations exceeding the NNC, Tetra Tech completed the WQBEL analysis by calculating the wasteload allocation (WLA) and long-term average (LTA) by following the procedure documented in the EPA Technical Support Document for Water Quality-based Toxics Control (TSD) (EPA/505/2-90-001). To calculate the WLA, Tetra Tech used the equation below (shown as Equation 1 on page 132 of TSD).

Where:
Cs = ambient stream concentration upstream of discharge, mg/L
Qs = seasonal ambient 14Q5 flow (July – October), mgd
Qd = average design flow rate, mgd[1]
WQC = water quality criterion, mg/L

EPA provided Tetra Tech with a spreadsheet containing seasonal (July – October) 14Q5 values[2]. Tetra

[1] The TSD references the critical effluent flow and critical effluent concentration as Qe and Ce, respectively. For purposes of this document and the files associated with this project, references to the critical effluent flow and critical effluent concentration use Qd and Cd, respectively.
[2] Seasonal 14Q5 flow values were not available for the following facilities: MT0020044 (Lewistown), MT0020125

Tech reviewed the applicable fact sheets to determine if background data exist to calculate the WLA. Where background data are referenced but not provided in the fact sheet, Tetra Tech searched in ICIS or requested information from EPA and MDEQ. The 75th percentile was used to determine the background concentration upstream of the discharge. For facilities that have not collected background instream data, Tetra Tech identified nearby monitoring stations with nutrient data using STORET and NWIS. This information was provided to EPA for review and discussion, and to MDEQ to determine which facilities have sufficient background data.

Tetra Tech calculated the chronic long-term average (LTA) based on the 95th percentile in TSD Table 5-1. Where possible, Tetra Tech calculated the coefficient of variation (CV) for data sets containing at least 10 data points; otherwise, used a CV of 0.6. Using the LTA and Table 5-2 in the TSD (at n=4 and 95th percentile), Tetra Tech calculated the average monthly limit. The average monthly limit is the WQBEL required for each discharger to meet the NNC and is summarized in Excel.

Facilities required to meet a WQBEL with < 2 mg/L TN monthly average will be considered to be within the cost threshold to qualify for MT's existing general variance. (For these facilities, EPA considers it reasonable to assume that RO would be required to achieve the effluent concentrations.) No further analysis will be needed. If the WQBEL exceeds 2 mg/L TN monthly average, EPA and the contractor will review the facility details before proceeding with the economic analysis.

Tetra Tech organized the facility information, for dischargers with WQBELs greater than 2 mg/L TN monthly average, into the following groups: TN concentrations of 3-4 mg/L monthly average; 5-6 mg/L TN monthly average; >7 mg/L TN monthly average.

DMR Data Analysis Methods

Summary statistics were generated from DMR data for 20 of the 21 facilities for TN, TN_CALC, and TP[3]. Discharge monitoring report data reported between April 2010 and July 2015 were downloaded from ICIS.

DMR data with the shortest statistical basis was used for determining the maximum effluent concentration (Cmax). Other screening factors were performed for calculating Cmax, which included the following:

1. For facility data that spans more than one permit cycle, if the type of data reported changed between permit cycles, the most current and shortest statistical basis used to calculate Cmax.
2. For facilities that underwent modifications between 2010 and 2015, and those modifications would have altered the treatment of nutrients in the facility, DMR data were screened to the month when treatment processes were modified and going forward.
3. For facilities that were marked as having unreliable data in their Fact Sheets/Statements of Basis, DMR data were screened to only look at data points MDEQ considered to be reliable.

(Chinook), MT0030309 (Grass Range), MT0020052 (Choteau), and MT0021750 (Absarokee Sewer District). For Lewistown, Chinook, and Grass Range, the 7Q10 was used as the critical ambient flow. For Choteau and Absarokee Sewer District, the minimum seasonal ambient flow reported (Choteau: 2011 through 2015 [June-September of each year]. Absarokee Sewer District: 2010 through 2011 [July-September of each year]) was used as the critical ambient flow.

[3] MT0030309 (Town of Grass Range) did not report any measureable DMR data between 2010 and 2015. The facility's 2011 Fact Sheet listed one effluent discharge that occurred during the previous permit cycle in June 2008. Discharge data reported during that month was used in the DMR data analysis.

Summary statistics were generated by outfall (count, average, maximum, standard deviation, minimum sampling month, and maximum sampling month). TN_CALC was calculated by summing NO_2/NO_3 and TKN for observations when TN was not present. The only other Nitrogen species available were nitrate-N without other species data, so those observations were not utilized. The CV is a calculated field based on these data. Data from the minimum duration statistical base code was preferentially selected (daily over weekly over monthly over quarterly). Data were included if the monitoring date range fell anywhere within the criteria application range for that facility.

See spreadsheet 'MT_DMR_Effluent_Analysis - (9-7-2015).xlsx' for assumptions and results.

Ambient Data (STORET and NWIS) Analysis Methods

Summary statistics were generated from ambient monitoring data for 21 facilities for TN and TP. Ambient water quality data were downloaded for the last ten years (1/1/2005 - 9/2/2015) from the Water Quality Portal[4]. Data were only available for MT0020052 within the last 15 years (2003) so these data were also included. Summary statistics were generated by NPDES ID (count, average, maximum, standard deviation, 75th %tile, min sampling month, max sampling month, min date, and max date). Non-detect values were reported as the detection limit or zero in rare cases when a detection limit was not reported. Results were screened using comment fields to remove QA/QC samples and according to comments that call the quality of the data into question. Data were included if the monitoring date range fell anywhere within the criteria application range for that facility.

TN - The following parameter names were all considered as TN: "Nutrient-nitrogen" and "Nitrogen, mixed forms". If more than one parameter was present on a sampling day, the results were preferentially selected in the order the parameters are listed. If neither of these parameters were included for a sampling day, the sum of TKN and Inorganic nitrogen (nitrate+nitrite) was computed. No further summation was necessary to obtain a data point for all sampling days.

TP - The following parameter names were all considered as TP: "Phosphorus" and "Phosphate-phosphorus". In aqueous environments, phosphate-p can provide a conservative estimate for total phosphorus concentration. If more than one parameter was present on a sampling day, the results were preferentially selected in the order the parameters are listed (e.g., phosphorus first, than phosphate-phosphorus). Some values were reported as Characteristic Name "Phosphate" with units "mg/L as P" so these values were converted to the "Phosphate-phosphorus" parameter.

See spreadsheet 'MT_Ambient_Analysis - (9-4-2015).xlsx' for assumptions and results.

Station Identification (GIS Spatial Analysis) Methods

The methods described here are for determining the nearest upstream ambient monitoring stations and USGS stream gages. Ambient monitoring stations with any available N or P species data were used and these data were matched to the final list of 21 facilities in the analysis.

There are 21 facilities for which we are computing values and considering for analysis. There are 431 USGS stream gages provided in "Tables_Coop.xlsm" which were provided to Tetra Tech by EPA along with guidance for which gages to apply flow data to each facility. There are also approximately 2,553 ambient water quality monitoring stations (Water Quality Portal) with some species of either N or P within Montana (using data from the past 10 years).

[4] http://www.waterqualitydata.us/

Coordinates for each of the 21 facilities and their associated outfalls were also mapped in GIS to identify the receiving waterbody and spatial proximity to the USGS gauges and ambient monitoring stations.

GIS was used to determine the spatial relationship between these locations by way of flow direction. Flowpath is able to be visualized using state extracts of high resolution NHD flowlines retrieved from USGS (http://nhd.usgs.gov/data.html). Satellite imagery also aids in identifying spatial relationships. Attachment 1 includes two examples of the spatial variation encountered.

This analysis identified 18 facilities with ambient monitoring stations within 10 miles upstream of a facility outfall on the same stream channel. One facility was located on an unnamed tributary and ambient data from a nearby tributary of similar hydrologic features were used (MT0021857). One facility did not have any upstream monitoring stations and factsheet data were used in this instance (MT0023566). One facility used stations dating back 15 years in order to pull enough data upstream on the same segment of river (MT0020052).

Facility Exclusions

EPA provided a list of 157 facilities to review for potential inclusion in the analysis. The table below summarizes the number of facilities that were excluded from the analysis and the rationale for excluding them. Tetra Tech and EPA reviewed each facility and identified 136 that could be excluded based on permit status, discharge location, and other factors. The remaining 21 facilities were included in the final analysis.

Number of Facilities	Reason For Exclusion	Notes
28	General Permit Covered Facility	
19	Expired Permit/Permit under review	Includes one facility that is "permit not needed" (MT0030678)
18	Discharge to Ephemeral Stream	
16	Meets End-of-Pipe	
12	No Mixing Zone	
13	Discharge to Yellowstone River – No NNC	
8	Effluent Source – No reasonable potential for nutrients; nutrients not identified as pollutant of concern	
4	Discharge to Missouri River – No NNC	
4	Discharge to Clark Fork River – No NNC	
3	Discharge to Flathead River – No NNC	
3	Discharge to lake or reservoir	
2	Discharge to River Breaks: Level IV Ecoregion – Narrative Criteria	
3	Nutrient Limits in Permit	City of Missoula WWTP - current permit issued on 5/1/2015 appears to include WQBELs for TN and TP
1	Discharge to Madison River – No NNC	
1	No Discharge	
1	Missing Data	
Total: 136		

Results

The remaining 21 facilities were screened to determine whether their discharges were projected to exceed NNC. In cases where the projected discharges exceed NNC, WQBELs are calculated. Before determining the projected downstream concentration can be calculated, the critical effluent concentration must be measured using procedures established in Chapter 3 of the TSD for calculating a Reasonable Potential Multiplying Factor at the 95^{th} Percentile (see Table 3-2, p. 54).

Where:
RPM = Reasonable Potential Multiplying factor
z = 1.634 for 95 percent probability basis
$\sigma = [\ln(CV^2 + 1)]^{1/2}$
$\sigma^2 = \ln(CV^2 + 1)$
CV = coefficient of variation (For data sets with at least 10 data points, calculated by dividing the standard deviation of the data set over the mean effluent concentration [CV = σ/μ]; for data sets with 1-9 data points, CV = 0.6.)
p = the z-statistic at the 95 percent confidence level = $(1 - 0.95)^{(1/n)}$
n = number of valid data samples

After calculating the RPM, the critical effluent concentration (Cd) is calculated using the following equation:

Where:
Cd = critical effluent effluent concentration at the 95^{th} Percentile, mg/L
Cmax = maximum effluent concentration, mg/L
RPM = Reasonable Multiplying Factor

The following factors were used to calculate the projected downstream concentration:

Where:
Cd = critical effluent concentration at the 95^{th} Percentile
Cs = ambient stream concentration upstream of discharge, mg/L
Cr = resulting or downstream pollutant concentration
Qd = average design flow rate, mgd
Qs = seasonal ambient 14Q5 flow (July – October), mgd[5]
Qr = downstream flow (sum of Qd and Qs), mgd

[5] See Footnote 1 above

Using these outlined procedures, Tetra Tech determined that 11 of the 21 facilities had discharges that were projected to exceed NNC (both TN and TP). WQBELs for both TN and TP were calculated using the procedures outlined in the WQBEL Methods section on page 1 of this document. For facilities requiring an economic analysis based on the calculated WQBELs for TN, the following table outlines which facilities did not require WQBELs for TN, facilities with calculated WQBELs in discrete ranges, and facilities whose calculated WQBELs were the NNC for TN:

No WQBELs required for TN	MT0020001, MT0020044, MT0020303, MT0020354, MT0020478, MT0020656, MT0020753, MT0028665, MT0030732, MT0021440
AML < 2.5 mg/L	MT0020052, MT0021750, MT0022713
AML 2.5-4.9 mg/L	MT0020028, MT0020125
AML 5-6.9 mg/L	MT0022535, MT0030309
AML ≥ 7 mg/L	MT0030295 (Outfalls 001 & 002)[6]
AML = WQC	MT0021211, MT0021857, MT0023566

[6] For the City of Roundup WWTF (MT0030295), Outfall 001 discharges to the Musselshell River, whereas Outfall 002 discharges to impoundment/wetlands. Both outfalls discharge the same waste stream coming from the facility, so the reasonable potential analysis was performed on both outfalls because the treated wastes could be discharged to a surface water outfall (Outfall 001).

Attachment 1. Example Maps of the Spatial Analysis Methods

Figure 1. Monitoring stations on same stream channel upstream of the City of Hamilton WWTP.

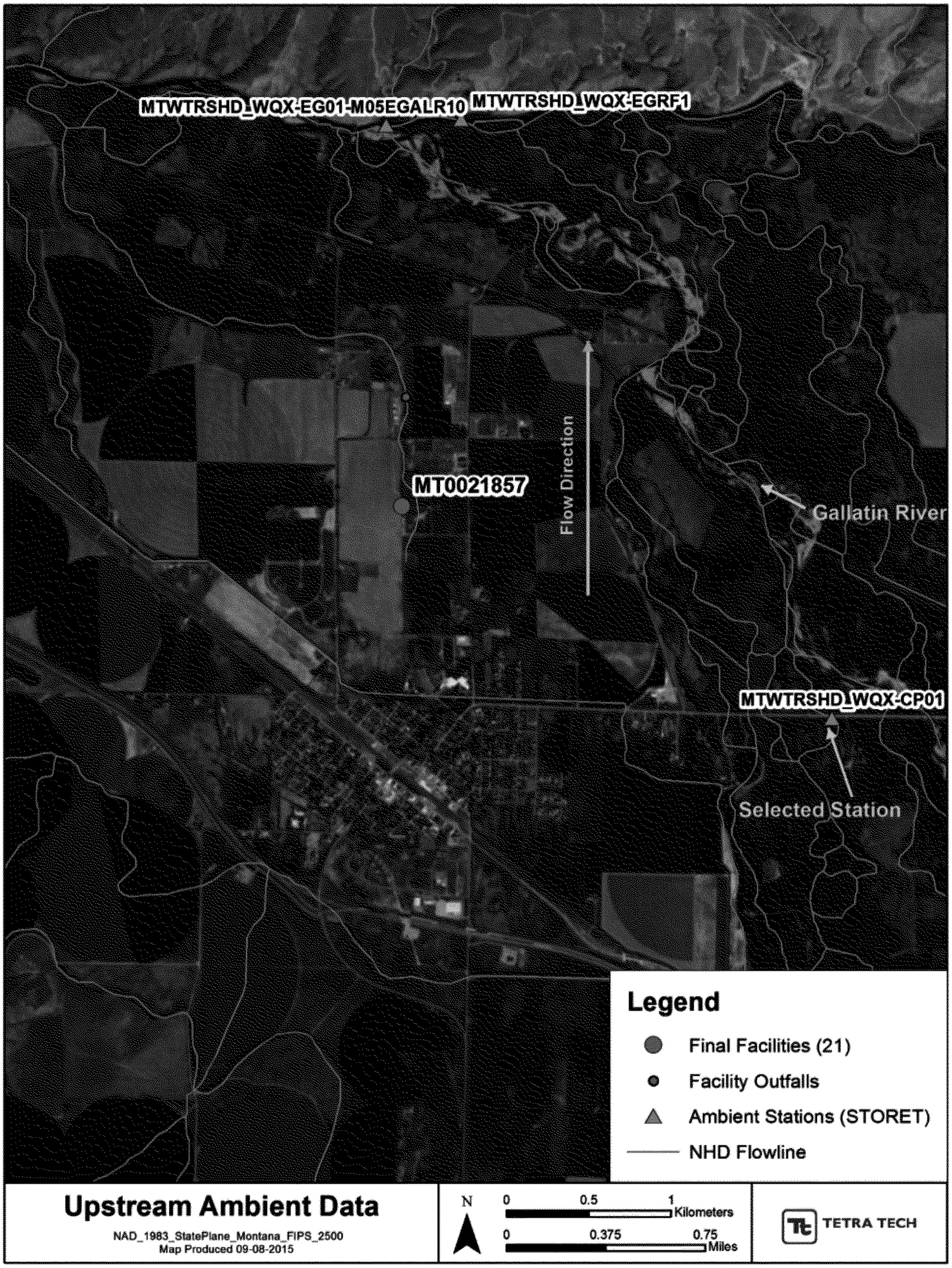
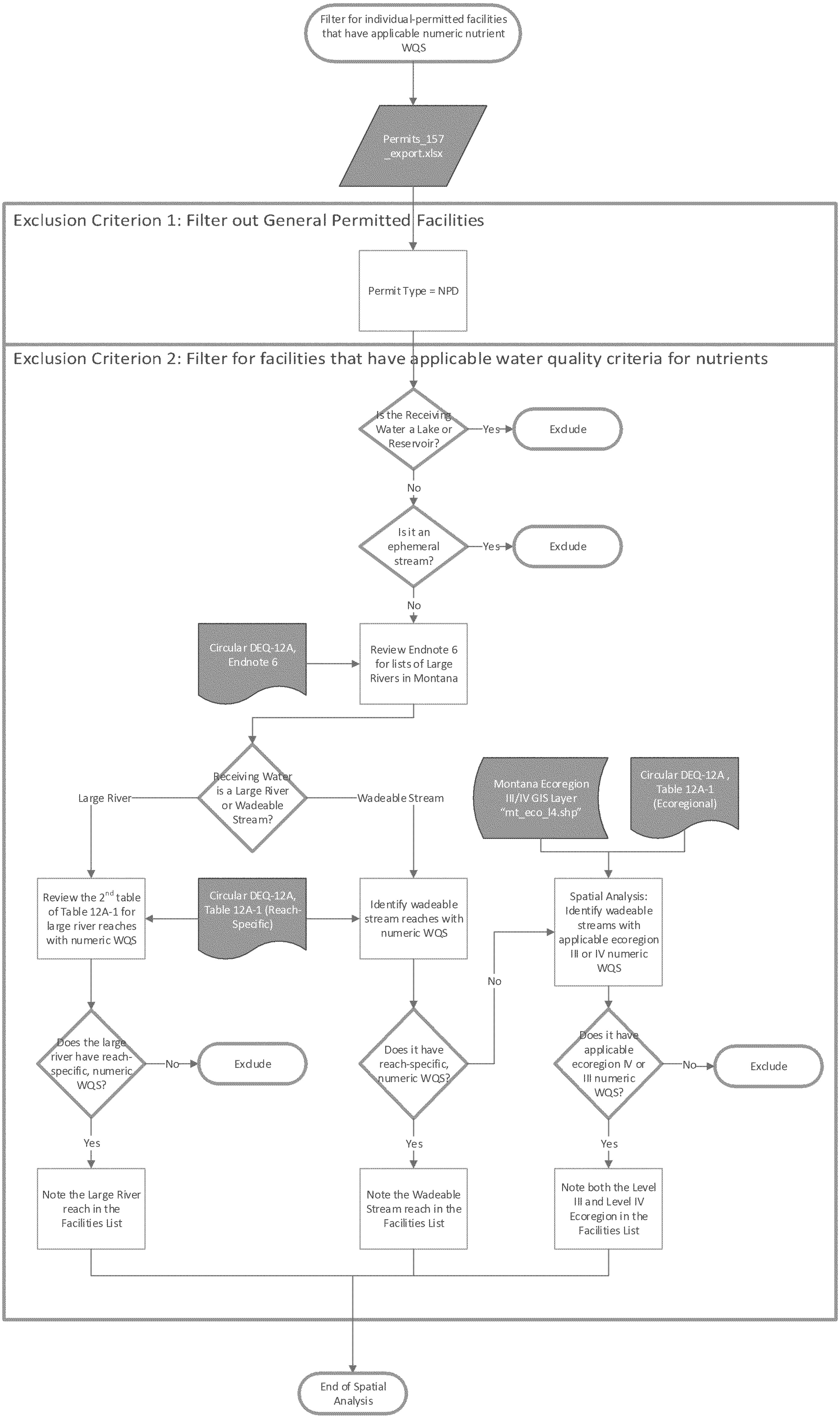


Figure 2. Monitoring stations on similar hydrologic tributaries discharging to the Gallatin River.

Attachment 2. Flowchart for screening facilities with applicable NNC


Filter for individual-permitted facilities that have applicable numeric nutrient WQS
Permits_157 _export.xlsx
Exclusion Criterion 1: Filter out General Permitted Facilities
Permit Type = NPD
Exclusion Criterion 2: Filter for facilities that have applicable water quality criteria for nutrients
Is the Receiving Water a Lake or Reservoir?
Yes
Exclude
No
Is it an ephemeral stream?
Yes
Exclude
No
Circular DEQ-12A, Endnote 6
Review Endnote 6 for lists of Large Rivers in Montana
Receiving Water is a Large River or Wadeable Stream?
Large River
Wadeable Stream
Montana Ecoregion III/IV GIS Layer "mt_eco_l4.shp"
Circular DEQ-12A, Table 12A-1 (Ecoregional)
Review the 2nd table of Table 12A-1 for large river reaches with numeric WQS
Circular DEQ-12A, Table 12A-1 (Reach-Specific)
Identify wadeable stream reaches with numeric WQS
Spatial Analysis: Identify wadeable streams with applicable ecoregion III or IV numeric WQS
Does the large river have reach-specific, numeric WQS?
No
Exclude
Does it have reach-specific, numeric WQS?
No
Does it have applicable ecoregion IV or III numeric WQS?
No
Exclude
Yes
Yes
Yes
Note the Large River reach in the Facilities List
Note the Wadeable Stream reach in the Facilities List
Note both the Level III and Level IV Ecoregion in the Facilities List
End of Spatial Analysis